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NITROGEN STARVATION.

BY CHARLES E. WOODRUFF.

UNDER the leadership of Professor R. H. Chittenden of Yale University and several other physiologists here and in Europe, a new and dangerously false dietetic theory has received undue publicity among laymen. It is asserted that we eat much more of the nitrogen foods than we should, and that health and efficiency are enhanced by cutting down the supplies about fifty per cent., more or less, whereas the evidence seems to prove that most of the people of the world do not get enough.

It is only within comparatively recent years that the vital importance of nitrogen has been recognized. The older chemists and physiologists looked upon organic substances as carbon compounds, such as sugar, starch, cellulose and alcohol; but, as a matter of fact, living material is essentially a mixture of very complex nitrogen compounds, while the carbon substances are manufactured by living cells. It is highly essential, then, in all vital phenomena, to remember that living matter is an unstable compound built of nitrogen and needing nitrogen for its continued existence.

All the other elements entering into the composition of our bodies are essential to life, no doubt, for experiments show that we can starve a lower organism by depriving it of any one of them; yet the main element is nitrogen, for without it all growth ceases. Without nitrogen there is no life. The lowest organism can utilize nitrates, or ammonia in solution, or the mere oxides of nitrogen, or even nitrogen itself; but, in the higher animals, the only substances to which we should give the name of food are the proteids, or complex nitrogen compounds, derived from other organisms. The carbon foods—sugars, starches, fats and alcohols—really deserve the name of fuels; for, though they do

become parts of some of our tissues and enter into the very substance of the cells, their main purpose, as far as now known, is to burn up to release their stored energy.

The amount of carbon fuel-food necessary for health is so dependent upon the work done that discussion of it is almost futile. A steamship at her dock requires but little fuel for heating and to run her necessary machinery, but when at full speed her consumption is enormous. Man follows the same rule, for he is a heat-engine too. The ship is built of many things, but the basis of all is the element iron, and for growth and repair iron is to the ship what nitrogen is to man. It is quite evident that a ship which makes many trips at high speed needs more repairs than a "sedentary" one at her dock, and in the same way a man who works much requires more than he who works little. It is not possible, then, to state exactly how much nitrogen any particular man should have, nor can we give a standard to which all men should conform, whether sedentary professors or active coolies. Indeed, there is some evidence that proteids can be as safely used for fuel in man as they are in the carnivorous animals, for some healthy races are largely though not entirely carnivorous.

There is a wide-spread opinion that the excess of protein puts some kind of a curious "load" on the liver and kidneys, though no one has ever been able to prove it. Physicians "relieve the load" by a milk diet containing large quantities of nitrogen in the casein. In addition, it was once thought that over-indulgence led to gout and rheumatism, but it has long been known that those diseases are most prevalent among the underfed poor. As a matter of fact the world over, the higher classes are fed with an abundance of nitrogen and are the healthiest, longest lived, most energetic, best developed and freest from disease. In India there is still an opinion that abscess of the liver is due to overeating, but it is now known to be due to infections, and that the well-fed nitrogen-eaters are less liable to it than the starved.

What makes the matter still more unaccountable is the overwhelming evidence of wide-spread semi-starvation among the lower classes in every part of the world. The explanation of this well-known fact is not so well known, but it is quite easy, nevertheless. As all biologists now acknowledge, there are more individuals born in every species than can possibly survive, and

there is a struggle for existence which is, in some part at least, a struggle for subsistence. There is not enough nitrogen to go round, and those who get the most grow best and survive over the less well fed. This law being universal, applies to man as well as to bacteria. Not only are periodical famines reported from many parts of the world, but even among the best-fed nations there are starving classes, as our settlement-workers know too well.

Now, it has long been noted that nitrogen, being the essential for which the demand is so great, has always had a high price. Carbon foods cost a few cents a pound, but dried protein costs a dollar or more, and foods rich in nitrogen are the most expensive — eggs, milk and meat. An insufficiency of nitrogen, therefore, is the main defect in all Old World dietaries, at least where there is overcrowding of the population, and observations show that the higher classes the world over do consume far more nitrogen than the lower. In Germany there is a chronic meat famine, and throughout the northern half of Continental Europe horse meat is a staple—even dogs are slaughtered under official inspection in Germany. Nevertheless, in some places the peasant rarely if ever is able to buy meat of any kind. In the crowded tropics nitrogen is still more rare, and there is a veritable nitrogen thirst among all the rice-fed natives. A feast or *fiesta* is not of dainties, as with us, but is a solid repast of meat. How serious, then, would be the error of accepting low nitrogen dietaries as the normal, when nitrogen underfeeding is the cause of the lack of growth and the susceptibility to disease so characteristic of the lower classes. Moreover, through the more abundant nitrogen diet of America, the children of undersized immigrants develop, as a rule, into fine specimens, and are able to do far more work than their cousins who have stayed at home. Over and over again have the official experts of our agricultural experiment stations made feeding experiments with domestic animals and shown that, by liberal nitrogen feeding, animals grow better and in every way are superior to those with a diet excessive in everything except nitrogen. Botanists long ago gave the name of “nitrogen starvation” to the condition of plants in which this first essential of life was deficient, and no better term can be applied to the underfed peasantry of Europe.

In England and other countries it has been found that de-

fective development and what is called degeneration are largely due to defective nitrogen nutriment supplied to the young both before and after birth. For many years observant English schoolmasters have noted the irritability of underfed schoolboys and the deplorable condition of the girls, whose food is mostly the carbon compounds. When nitrogen is increased—meat twice a day—the children become normal. The same observation has been made with other carnivorous animals—for we are carnivorous at least in infancy—and they, too, show grave inanition when the nitrogen is reduced.

The traditional military policy of the United States Government has been to increase the liberality of the soldier's food. We have much more to accomplish, for we are still behind European nations. A comparison of our maximum ration with the maximum war rations in Europe some years ago revealed the astonishing fact that ours is one of the worst in the world. Dependence upon it always results in emaciation and weakness, so that restaurants in and around armies and garrisons are absolutely essential and every soldier spends a large amount of his pay for food, and, significantly enough, his favorite tidbit is ham and eggs—nitrogen. These facts were denied by a military sanitarian at the time the publication was made, and he stated that our ration was the best in the world and not susceptible of much improvement. Yet Congress has been repeatedly compelled to increase the soldier's ration. In addition, Representative Littlefield made an effort to obtain fifty cents monthly for each soldier to buy extras, and I have personally long advocated such an allowance.

Though the European war rations are very large—the husky Russian soldier receiving two pounds of bread a day in comparison to our one—the peace ration, particularly in Germany, is small, because the soldier is expected to get money and food from home. It is part of every one's tax to serve in the army, and, later, to feed his sons who are serving there. It is calculated that the 600,000 German soldiers spend for food over and above their ration the enormous sum of one hundred million dollars or even two hundred million, if we count in the extras of the sons of well-to-do parents. The Danish soldier in the West Indies was once held up as a proof that low diet will suffice, for he was given but four ounces of meat; yet it was not mentioned

that he got fifteen cents a day to buy more. The English were compelled to give the soldier more meat in India than in England.

In view of these facts, it was with amazement and dismay that the writer learned that a squad of soldiers had been starved by Professor Chittenden to prove that the ration was really over-feeding them! The matter was so important that the men were traced to get the real facts, which every military sanitarian knows were not at all what Professor Chittenden thought they were. At the end of the experiment the men were photographed, weighed, tested and declared to be in far better condition than at the beginning of the experiment—a statement so much at variance with the military experience of the world as to be incomprehensible. The reports received in 1905 and 1908 cleared up the matter at once.

One said "that he felt badly throughout the test, and that his health and strength improved immediately on stopping it," and that he did not continue the low diet. The second lost twelve pounds in the test and was always hungry, but he regained his normal as soon as he returned to normal diet. The third thought he received some benefit, but he returned to normal diet and normal weight. The fourth said that his nervous system was permanently damaged; he continued the diet three months, but stopped it because he became weak, nervous and dizzy and had frontal headaches. He lost weight, but upon return to normal diet he gained weight and lost his abnormal symptoms. The fifth did not find the diet beneficial in any way, and it was unsatisfying, though he was not damaged as far as he knew. The sixth and seventh merely stated that they did not continue the diet and were in excellent health. The eighth was so impressed with the harmfulness of the diet that he believed he would have died had he continued it. The ninth continued the diet and was in good condition. Surely this is a record to deter other experimenters in the line of starving human beings.

All this is bad enough for the greatly reduced diet which it is supposed the men ate, but it becomes far worse when it is realized that it was the result of a better diet than reported. Hungry men will eat, and persistent rumors stated that the men had secretly partaken of "square meals" now and then. These rumors proved to be correct. One of the men made the following statement:

"In giving a true and concise statement of the matter, I do so, believing it will not compromise me now. From the time the experiment first began up to the termination of the same, I gradually lost weight and strength, believing the same due to insufficient amount of food, especially meats. At the time of the test, I was six feet in height, weighed 160 pounds, and was in good health. During the test I lost twenty pounds in weight. Apparently some of the smaller men did not fare as badly as I, but all expressed a dissatisfaction with the whole affair.

"I was not sick during the test and have not been since to speak of, but I felt like an old man at the end of the experiment. It seems that I felt weak and had no energy or ambition for anything. However, I have experienced no bad effects since undergoing the test.

"As to the matter of eating outside, I do not believe that there was more than one man taking the test who did not eat as well as drink on the outside whenever he had an opportunity. Private —, I believe, adhered strictly to the test in every respect. Being an old man, he did not avail himself of the privilege of going out in the evening, but at the end he looked much older than before and expressed his dissatisfaction. As for myself, I will say that I ate on the outside occasionally and believe, had I not done so, I would have starved.

"During the test we were given gymnastic exercises, which were highly appreciated by the men; but toward the end the men became so weak that the exercises early exhausted them, and sometimes many of them were hardly able to reach their quarters.

"It is my belief that the reports prepared and the books written regarding this test and its apparent success are greatly exaggerated, and I believe all of the men on the test would so testify.

"As a reward for our services on the test, we were sent for duty to the World's Fair at St. Louis with the United States Army Medical Department exhibit, and as soon as we were returned to full diet every one seemed to gain rapidly in strength and weight. Within three months after the test I went from 140 pounds in weight to 170 pounds."

Though most of the men did eat secret extra meals now and then, it was not sufficient to make up a normal diet. The deficiency was extremely harmful, so that, if they had taken as small an amount as was reported, the result would have been disastrous. The reason for the concealment was the fact that the men had been disobeying orders and were afraid of the consequences of discovery; and the weakness and distress had been concealed with all the rest. As a scientific experiment, the whole thing falls to the ground.

The result being the opposite of what was reported, it is quite evident that three of the most remarkable blunders possible in a scientific investigation were committed. In the first place, the "probable error" due to unknown factors and unavoidable faults

of observation was not estimated. The possibility of extra sources of food should have been fully stated and emphasized, for failure to enlarge upon it has given the impression that the men lived on far less food than was actually the case. No investigation ever gives exact results, but the probable error is invariably calculated.

The second blunder is of far more importance, and that is the neglect of the "factor of safety." It has long been known that by natural selection in times of stress only those organisms survive which are much stronger than necessary in ordinary times. Hence each organ is built on good engineering principles with a factor of safety varying from six to twenty, or that many times stronger than need be for ordinary stresses. This is now known to be the reason why we must eat just a little more than we expend, to have a surplus to store up in a physiological bank account for times of infection when there is a "run" on our resources. The man with no surplus goes under like a bank with no reserve. The normal man always has a good layer of fat under the skin, and the very fact that he does not go on increasing in weight like a prize pig is proof that the appetite and other conditions prevent undue excess. No animals store up tremendous quantities unless it is for some special use. To be sure, there are types developed by man for the purpose of manufacturing fat, but these animals would promptly perish unless man preserved them. Experiments with cavalry horses have shown that when satiety comes they drop back to the ration, refusing any surplus offered. Obesity is a disease and is not due to diet primarily. Hence we find that, with plenty of food available, we are not able to take more than a small surplus for future emergencies, and unless we do take it we are unable to weather the storms of life.

In the cure of tuberculosis, for instance, the main factor is the outdoor life, but the next important factor is nitrogen nutrition—not stuffing the patient, but giving him a generous diet of milk, eggs and meat to the limit of his digestive powers. The results are marvellous and leave no reasonable doubt that the main reason why the tissues lost their resisting powers was the fact that they had previously suffered from deprivation of nitrogen. Sometimes other diseases leave the cells impoverished so that tubercle bacilli find a favorable soil, and sometimes the patient, though fat from consumption of carbon fuel-food, has

neglected the real nitrogen foods. Alcoholics often succumb for this reason, for it has recently been shown that neither excessive indulgence nor total abstinence of themselves are factors of importance. Sometimes chronic indigestion prevents the proper supply to the cells; and, finally, what is far more to the point, recent study of various forms of protein shows that some, though digested by one species of animal, are incapable of digestion by another, and that more or less of the protein we ourselves eat is useless as food. It is highly essential, then, that we eat more than enough to allow for indigestible and unassimilable portions—if we are to keep ourselves in a condition whereby our cells may destroy the living tubercle bacilli we are daily liable to take into our bodies. The factor of safety must be large or we perish. The theory of the low-diet faddists, that tubercular susceptibility is due to overeating, has nothing to support it, is opposed to all we know of the disease and is most dangerous to public health. It is not a disease of the well fed.

Even in the lower animals we find evidence of importance, for it has long been known in zoological gardens that, as a rule, with some exceptions, due possibly to bad ventilation, vegetable feeders are twelvefold more susceptible to tuberculosis than the meat-eaters. Moreover, foxes and rats on a carnivorous diet are nearly immune, but more than twice as susceptible on a vegetable diet, though fat and apparently thriving. Likewise milk-fed calves rarely contract tuberculosis, even when fed from tuberculous cows. It is also found that the carnivorous New World monkeys rarely contract the disease which is common among the vegetarian Old World species, and the latter are preserved in greater numbers by adding nitrogen to the diet, even if it be given as a sloppy beef tea.

Beri-beri is another microbic disease which does not attack those with a big nitrogen bank account. Well-fed Europeans in the Orient never contract beri-beri—practically speaking. In northern latitudes, relapsing fever and typhus rarely attack those fed upon an abundance of nitrogen. Like beri-beri, they are found among the underfed. Similarly, cholera, the plague and other infections are also dreadfully fatal to rice-fed Orientals, who are able to do immense labor by the oxidation of these carbon fuel-foods, but whose tissues are in a condition of nitrogen bankruptcy. Well-fed Europeans not only escape the diseases, as a

rule, but when they are infected a much larger percentage recover. This is the reason why the English army was compelled to increase the meat ration in India, and it is now an axiom that in the exhaustions of a tropical climate more nitrogen is needed than at home. In spite of these well-known facts, Dr. Wiley, the Government food expert, not so long ago advocated a reduction of nitrogen in the tropics and a fruit diet. If we would follow that advice tropical campaigns would be impossible, and as an actual fact the digging of the Panama Canal was found to be impossible if laborers were not fed with plenty of nitrogen supplied by Government commissaries. Experience showed that on the fruit diet they were as feeble as the soldiers on Professor Chittenden's diet. Meat is now making the dirt fly, and this great revolution was made by a layman, in spite of the foolish theories of the dietetists, and he did it because he found that the healthiest men were the well-fed prisoners in jail.

Evidence of starvation among the submerged tenth can be found aplenty in all works on poverty. The results in destruction of health are the reasons for the existence of about 50,000 more American physicians than there would be if every one could get and use as much nitrogen as his tissues demand, and that amount varies with the work. It need only be mentioned here that, if our present death rate continues, ten million Americans now living are doomed to die of tuberculosis, and Robert Hunter estimates that ten million of the inefficient classes are constantly on the verge of underfeeding and often are unable to get enough.

The third blunder is the assumption that these fat-free "trained" men with cordlike muscles are normal, whereas they are abnormal to a degree. We must repeat that the normal man has a layer of fat under his skin. These "trained" men were able to lift weights, make records on dynamometers, run a mile or perform a short test, but they had no staying power. The purpose of the "training" of athletes and horses is to produce powerful breathing muscles, and a big heart which will be able to do tremendous pumping of blood for a short time of excessive activity. Only the young organism will react to such practices, and it is left with something it has little use for in later life and which might be injurious—an hypertrophied heart which may later become dilated. Now and then there is a desperate effort made to prove that "training" is not harmful, but the argu-

ments are woefully misleading and not based on facts. There is plenty of evidence that young men able to indulge in sports are longer lived than those too frail to make records. No one denies that; but it is far from proving that the recent craze for "training" immature boys is productive of longevity. The after-lives of professional athletes are not over-long nor over-healthy.

Now, the whole aim of military training is the exact opposite of college athletic training. It is designed not to enlarge the hearts, but to give a great store of surplus energy to enable soldiers to endure long strains with a minimum of harm. No man can go through a long war without injury to health—it is beyond human endurance—and the tremendous pension roll is evidence of that fact—not evidence of fraud, as so many people hint. There is a prevalent idea that we must train soldiers by subjecting them to the real strains of war, but that is as dangerous as submitting them to actual gun-fire to teach them how to stand up before bullets in battle. Athletes make poor soldiers, as a rule, for they are able to make severe exertion for a short time instead of less exertion for a long time, and they have no reserve force.

We will do well to increase the ration even more and make it unnecessary for soldiers to buy extra food as at present. Civilians who wish to sink into a condition of nitrogen starvation must take the consequences of possible physiological bankruptcy.

Professor Chittenden proved, what military sieges have proved for thousands of years, that people can exist in a weakened state for long periods on a restricted diet. But he proved something infinitely more important, something which has also been known for a long time; and that is the fact that muscles can be compelled to store up nourishment needed elsewhere. While the nervous system is crying out for food, we can cause the muscles to grow big. Athletes often, if not generally, are on the verge of nervous exhaustion and if not managed with exquisite skill they are "stale"—another word for neurasthenia. This is the reason why so many old professionals resort to alcohol or become victims of tuberculosis. Many a college athlete is unable to apply himself to his books, and it is found absolutely necessary in all colleges to cut them off from athletics when the exhaustion has gone that far. Every scholar should take part in athletic sports, but not be a "trained" athlete nor flabby "bookworm."

It is high time that the science of dietetics should free itself of the horde of parasitic fads which have fastened themselves upon it. It is the black sheep in the flock of sciences which make up that greater science called "medicine," and it has been under a cloud long enough. Nothing is too absurd to be advocated, from a diet of peanuts to one of raw meat. For many years the real science of dietetics was content with a mere study of what people were eating in all walks of life in every part of the world. It was sad enough to have the illogical conclusion once thrust upon us that these dietaries were necessarily correct, without regard to the results as to vigor and immunity from disease. Indeed, no one seemed to think that the coolie ate rice because it was the only thing he could get, and that he greedily ate better food whenever he had a chance. When the real scientists took up the work of experimental dietetics, it was with keen expectation that the medical profession looked forward to enlightenment—and the enlightenment we got was the new fad that we eat too much of the thing of which we are built, a fad which will destroy a nation as surely as it will destroy an army. Long before there was a "science" of dietetics, Napoleon said that an army "travels on its stomach," and every other man who has ever had the management of bodies of workers has said that they work on their stomachs. And we can apply the same rule to the nation and to the whole race.

Though we cannot build a ship without iron or a man without nitrogen, yet, after the building is done, we can well reduce these elements; and it is surprising the small amount of nitrogen with which an old sedentary man can retain efficiency—but that is another story, for we are here concerned with the danger of insufficient nitrogen until well along in middle life. It has been reported that within a year two college boys have died while subjecting themselves to low nitrogen diet, and in each case the physicians in attendance were of opinion that the lowered vitality from partial nitrogen starvation was the real cause of death. Names and places have been suppressed as a matter of course, but there does not seem to be any doubt as to the reality of the facts. So let us teach good feeding, and then, perhaps, we will not hear of so many students who have broken down from "over-work," which is too often, if not always, "underfeeding."

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